2 May 1960

Dear Dick:

PROGRESS REPORT #8

Progress on the design and construction of the A-12 vehicle during the month of April and the current status of certain important problems are outlined below. This report will be quite brief, because of our suppliers' meeting to be held a few days from now, where many of these items will be reviewed more thoroughly.

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1. [redacted]

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2. AERODYNAMICS

A study of the turning radius and its effect on altitude and range was sent to Gene Kiefer this morning. The major accomplishment during April was completion of tests on a scale model to establish the levels of temperature and pressures on the aircraft. While complete data are not yet available, there is every indication that the temperatures on the whole aircraft run slightly lower than what we have assumed. There are two areas where they run high, one being the leading edge of the canopy and the other being the section of the wing immediately inboard of the leading edge of the nacelle. We can handle both of these problems. Pressure distribution checks our initial estimates almost exactly, so I feel we are in good shape in regard to our aerodynamic and temperature data.

It is interesting that the model for these tests costs considerably less than $50,000. A similar model, made by other processes, for the X-15 cost over a half million dollars, we have been told. Our model was made from two simple stampings welded together, leaving hollow areas for instrumentation. The X-15 model was machined out and obviously gave great difficulty in installing the temperature and pressure leads.

Analysis of high speed data on the nacelle tests indicates too high drag from the nacelle bleed system. We are working with P&W to reduce the amount of bleed pressure required; so that we can return to the simpler form of boundary layer bleed which we originally proposed. P&W tests on the ejector should be completed shortly.

Studies made on the dynamic motion of the aircraft after engine failure at design dive speed and maximum impact pressure show critical tail load responses. In discussions with P&W, we have considered periods as short as one one-hundredth of a second for losing thrust on an operating engine. In this period, the pilot could not apply corrective rudder action. To prevent high angles of yaw, therefore, automatic signals are placed into the yaw damper to apply 8 degrees of rudder in about two one-hundredths to four one-hundredths of a second. This keeps the yaw angle essentially to zero and the vertical tail loads in hand. Whether or not the engines will ever lose thrust in this incredibly short period is debatable, but in this stage of the game we have no alternative but to provide for the emergency.

We are setting up mathematical data required to put into a dynamic simulator at Ames Laboratory, where we have made arrangements to "fly" the airplane, both with and without artificial stability augmentors. These tests should be extremely useful in telling us what the flight characteristics will be. This same procedure was used on the F-104, using a variable stability airplane for a simulator, with excellent results.

3. DESIGN STATUS

Engineering design is on schedule, with something over 600 drawings released. The mockup is in the usual state of being re-arranged for small differences in instrument panel and cockpit arrangement, but is essentially complete. We are doing a great deal of testing on static test panels, barrel sections, and a host of other elements of the aircraft, such as cables, bearings, rod ends, hydraulic elements, etc.

4. TITANIUM PROBLEMS

During April, a great deal of difficulty developed in the processing and qualification of titanium sheets. We have instituted what I believe to be the most rigorous testing procedure, not only for the raw material but also for the parts that are built and heat treated, along with test samples, to insure that the proper strength and ductility of parts are obtained. Thousands of samples have been constructed and tested. We rejected 40% of the material received from [redacted]. The basic problem there was that the material was too strong and brittle, averaging about 13% over the required tensile strength but at the expense of reducing the ductility to one-half of an acceptable value. In a two-day meeting with [redacted] representatives, we got them to agree to the return of most

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of the sheet stock in question, while we agreed to take other sheets, using a different heat treat cycle, on the assumption that it could be raised to the proper ductility. If this cannot be done, [redacted] have agreed to accept this sheet also, paying the attendant transportation and handling charges. We showed their technical people our complete method of processing, and have a letter approving our method of pickling and etching the material. In fact, they are apparently going to use the method we use. Some sheets were not returned, because [redacted] recommended considerably different aging cycles, varying from 24 to 72 hours. We must stabilize on some fixed value, which we believe to be 48 hours. Within the next month, [redacted] will give us a fixed heat treat cycle, so that there should be no discrepancy in heat treat time. The mere processing of these sheets, and finding out how and why good sheets could make poor parts, took an extreme amount of energy during April, with a net part rejection of about 10% after qualifying the sheet. 25X1 25X1 25X1

We have a problem of a different sort [redacted] 94% of the sheet received having been rejected. Their material has excellent elongation and a tensile strength which is satisfactory or better, but it is being sent to us at an average overweight of about 10%. They apparently expected us to etch away four one-thousandths of an inch on various sheets. This can be done, but the idea of leaving up to 25% of what is normally a .016 inch sheet in the pickling tank, [redacted] is quite offensive to us. We prefer to have this left back [redacted] with proper adjustment of the costs. They are scheduled to be given the treatment the week of May 9th. 25X1 25X1 25X1

We are having extreme difficulties in cost control on titanium forgings of all kinds for making critical parts for the landing gear and fuselage rings. The odd shapes of the latter and the very high cost of titanium staging dies make it advisable in one particular case to take a 1,000 pound billet and machine it down to a 66 pound fitting. We have investigated hand forgings, bolted up structures, finished forgings and plate to make these pieces, but the cheapest one starts with 1,000 pound bar stock. Of course, a considerable amount of this stock can be used to make other fittings, but the bookkeeping involved in keeping control of every piece of scrap and the large amount of machining make it a very costly operation. There are no alternative methods for building these parts, because of the tight requirements on weight and shape. We are making some excellent titanium pieces and have solved practically all machining problems, except how to cut on the inside of a curve without wasting

too much material. We intend to sponsor a research program, perhaps
25X1 with [redacted] in an effort to develop a very high speed friction saw for solving this problem. At the present time, we are flame cutting the billet, which is a rapid operation but which wastes from one to two inches of the billet stock, and which leaves a surface extremely hard to machine, because of the presence of titanium oxide.

5. POWER PLANT

We have continual dealings with P&W on daily problems, with several major ones unsolved. I am going to ask them for a failure analysis on the engine, as at the present time it appears, from their statement, that one engine cannot be shut off in high speed flight without ruining many expensive parts of the fuel system. We must be able to shut off an engine without this drastic effect, if for no other reason than to do single engine flight testing and training. I will take up this problem during our correlation meeting on May 17th.

P&W recently asked us about our feelings regarding changing the fuel specification to allow a freezing point of zero degrees F. I am writing them that this is entirely unacceptable, not only because of problems with the A-12, where they would be at a minimum, but mainly because of problems in storing and handling the fuel in the tanker. The minimum freezing point should be between -30° and -40°F. P&W state that some improvement in BTU's per pound can be obtained using fuels of higher freezing points.

25X1 During April, I sent [redacted] who is in charge of our flight test
25X1 operation, and [redacted] instrumentation engineer, to Florida to correlate tests and instrumentation on the ejector system. This is moving along well and the ejector is being built.

6. CONSTRUCTION

The major jigs are outlined and are being completed. Some parts are starting to go into the ejector jig, and the fuselage nose section should be started shortly. It seems extremely difficult to schedule parts of the aircraft, because of the long lead time on certain materials and the extreme amount of machining required to make many of the parts.

At the present time, we have [redacted] operating two shifts in the factory, 25X1
25X1 and [redacted] on the project. Availability of qualified material has held up progress, as discussed in paragraph 4.

7. COST

The cost situation is covered in a separate report.

Sincerely,

Kelly

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cc: [redacted]
J. P.